Keys to the *Notonecta* nymphs of the West Coast United States

(Hemiptera: Notonectidae)

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Ecological and life history studies of any group of insects require familiarity with the various stages of development. Of seven species of *Notonecta* (Hemiptera: Notonectidae) native to the West Coast of the U.S., the nymphs of only three species have been described. Nymphs of *N. indica* Linne and *N. undulata* Say were described in keys of Eastern U.S. *Notonecta* (Rice 1942, 1954), and McPherson (1967) described the nymphs of *N. hoffmanni* Hungerford. However, there are no descriptions of the nymphal stages of the other four *Notonecta* spp. of this area. The purpose of this paper is to present a key to the various instars of the seven *Notonecta* spp. native to the West Coast of the United States.

According to Hungerford (1933), seven species of *Notonecta* are native to California, Oregon and Washington: *N. hoffmanni* Hungerford; *N. shooterii* Uhler; *N. spinosa* Hungerford; *N. undulata* Say; and *N. unifasciata* Guerin. Keys were made for the first and fifth instar nymphs. The intermediate stages show characteristics in common with the first or fifth instars, therefore, it was unnecessary to develop keys for them. However, a table was included for the determination of the instar stage of any species, based upon the wing pad/thorax length ratios (Table 1).

It can be seen from Table 1 that for those species measured, wing pad/thorax ratios for any instar remain constant from one species to another. This contention is supported by figures of wing pad development in *N. undulata* (Hungerford, 1917; Fig. 4a–e) and *N. raleighi* (Rice, 1942; Fig. 9a–e) and by the verbal descriptions of the wing pad/thorax ratios of *N. irrorata* (Hungerford, 1919; p. 188–189). It is probably safe to assume, therefore, that those species and instars not measured would also fit Table 1.

Since *N. shooterii* has both flightless and normal morphs, careful measurements were made to insure that concomitant wing length reduction does not occur as was described for certain flightless *Buenoa* (Scudder 1965) and *Anisops* (Young 1961). Measurements were made on *N. shooterii* nymphs from a mixed population of flightless and normal morphs in which the former predominated. No differences

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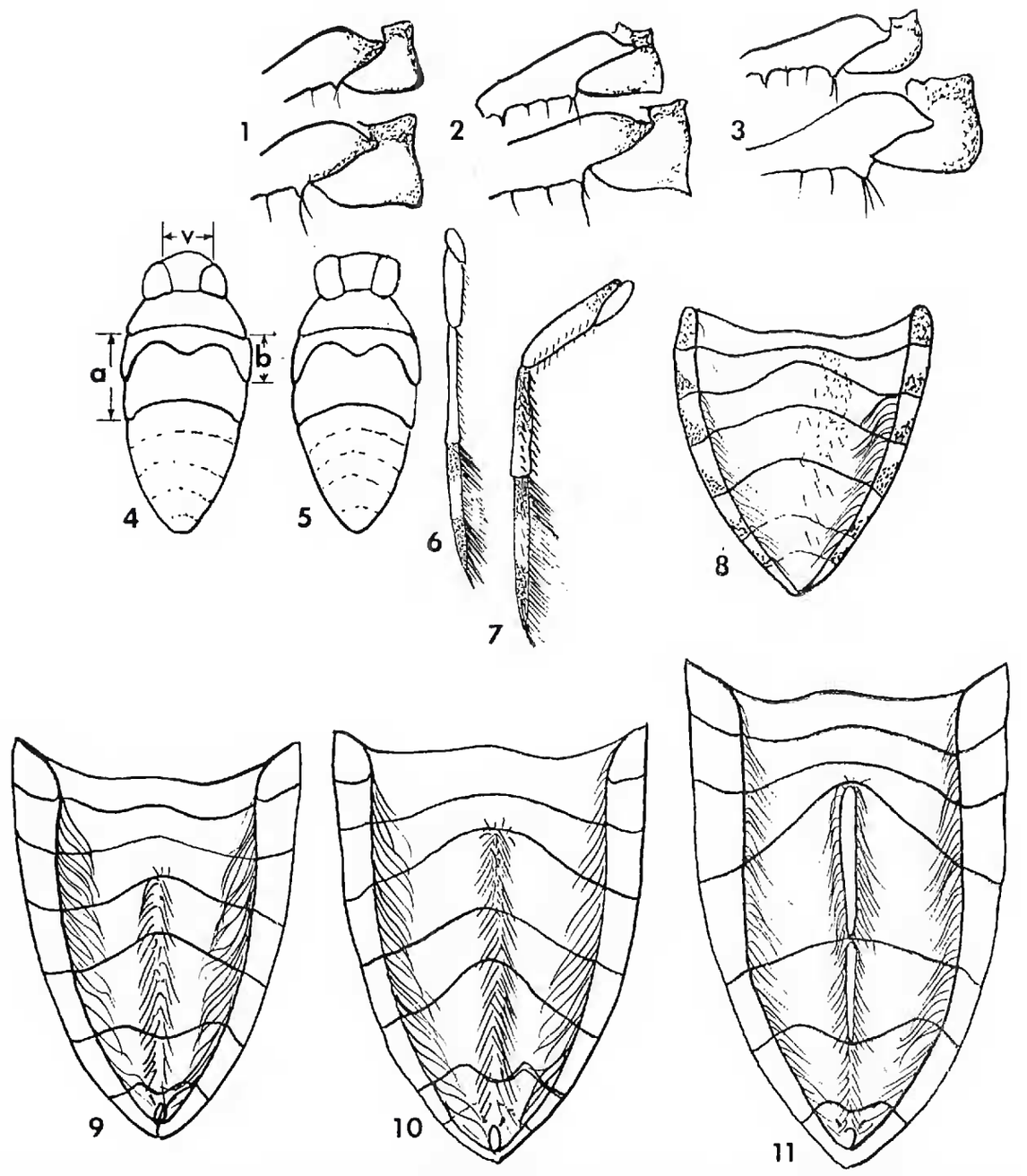
TABLE 1. Measurements of wing pads of *Notonecta* nymphs, and ratios of wing pad lengths. W, T, R refer to wing pad and thorax lengths in mm and wing pad/thorax ratios respectively. Values expressed ± one S. D. N refers to number of measurements.

Species		2nd	3rd	4th	5th
N. hoffmanni	W	0.44 ± .01	0.83 ± .02	1.44 ± .06	3.34 ± .16
	T	1.21 ± .02	1.75 ± .04	2.41 ± .07	3.55 ± .17
	R	0.38 ± .02	0.47 ± .01	0.60 ± .02	0.94 ± .04
	N	3	3	7	8
N. kirbyi	W	0.43 ± .04	0.84 ± .02	1.51 ± .04	3.82 ± .08
	T	1.09 ± .09	1.73 ± .02	2.50 ± .05	3.98 ± .08
	R	0.40 ± .01	0.49 ± .01	0.61 ± .01	0.96 ± .01
	N	5	5	5	5
N. shooterii	W	0.45 ± .02	0.79 ± .05	1.51 ± .08	3.55 ± .11
	T	1.17 ± .05	1.66 ± .07	2.46 ± .07	3.80 ± .16
	R	0.38 ± .01	0.48 ± .02	0.61 ± .02	0.93 ± .02
	N	5	10	10	10
N. unifasciata	W	0.34 ± .02	0.69 ± .04	1.19 ± .04	3.07 ± .2
	T	0.93 ± .06	1.33 ± .05	1.85 ± .1	3.92 ± .2
	R	0.38 ± .02	0.52 ± .01	0.65 ± .02	0.95 ± .02
	N	5	5	7	9
N. spinosa	W			1.19	2.95 ± .1
	T			1.87	3.18 ± .1
	R			0.64	0.93 ± .02
	N			2	4
N. undulata	W		0.64	1.28	1.13 ± .06
	T		1.36	2.18	1.22 ± .07
	R		0.48	0.59	0.93 ± .02
	N		1	2	3

were discernible between nymphs of either morph. Scudder (1966) noted that although *N. borealis* Bueno is a flightless species, there was no concomitant shortening of either wing.

Identification of the various species of nymphs was accomplished through associative rearings of field collected individuals and by progeny rearings from eggs laid by identified females. Field collected nymphs were sorted into various groups according to shape, size and coloration, and adults reared from each group were associated with the cast skins left by the moulting nymphs. Only a few late instar *N. spinosa* were collected, but since adults of this species were found associated with the nymphs, and because of the characteristic shape of the mesotrochanter of this species there was no doubt as to its identification.



FIGS. 1–11. Fig. 1–3. Right mesotrochanter and femur of 4th and 5th instar *N. unifasciata*, *N. spinosa* and *N. shooterii*, respectively. Fig. 4. Fourth instar *N. undulata*. Fig. 5. Fourth instar *N. indica* (Redrawn from Rice 1942 Fig. 3). Fig. 6–7. Hind legs of *N. unifasciata* and *N. shooterii*, respectively. Fig. 8. Ventral view of abdomen of 1st instar *N. undulata*. Fig. 9–11. Abdomens of 5th instar *N. undulata*, *N. shooterii* and *N. kirbyi*, respectively.

We were also unable to obtain any nymphs of *N. indica*, but this species was already distinguished from *N. undulata* which it closely resembles (Rice, 1942, 1954).

The more difficult species to distinguish were *N. unifasciata* from *N. spinosa*, and *N. indica* from *N. undulata*. The fourth and fifth instars of *N. spinosa* have a prominent tubercle or tooth at the posterior margin of the mesotrochanter (Fig. 2), whereas in *N. unifasciata* the mesotro-

chanter is acutely rounded but not toothed as in *N. spinosa* (Fig. 1). These differences might be less pronounced in earlier instars, however. *N. shooterii*, which shows some similarities to *N. unifasciata*, is much larger and has a rounded mesotrochanter (Fig. 3).

N. undulata and *N. indica* are very similar species, even in adult stages. Rice (1954) was able to separate first instars of these species by the presence of light and dark bands on the hind legs of *N. indica* and by the lack of banding on *N. undulata*. She also noted that the anterior margin of the eyes (dorsal view) of *N. indica* is at the same plane as the vertex, giving the head a flattened appearance (Fig. 5), whereas *N. undulata* has a more rounded head (Fig. 4). This characteristic was noted in all instars (Rice 1954). In most situations, a quick survey of the adults present will give a good clue as to the probable identity of the nymphs encountered.

A few definitions are in order for the use of this key. Wing pads and thoracies were measured along the lateral edges of the thorax (Fig. 4). The vertex refers to the anterodorsal interocular space (Fig. 4v), and total length is measured along the midline from the vertex to the tip of the abdomen. The number of setae on the most proximal mesofemoral tubercle varies from one to three depending upon instar and species, but for the purpose of this paper, they are all counted as one.

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KEY TO SOME WEST COAST FIRST INSTAR NOTONECTA (EXCLUDING *N. SPINOSA*)

1. Hind legs with conspicuous alternating light and dark banding, at least on the tarsi, and in some species continued onto the tibiae 2
— Hind legs concolorous, metatarsi perhaps tipped with dark, but definitely not banded 4
2. Size small, less than 2.2 mm, metatarsi banded but not metatibiae (Fig. 6) ..... *N. unifasciata*
— Larger than 2.2 mm long, metatibiae and tarsi conspicuously banded (Fig. 7) 3
3. Setae on metatibiae dark and stout ..... *N. shooterii*
— Setae on metatibiae pale and inconspicuous ..... *N. indica*
4. Metatibial setae dark and stout ..... *N. hoffmanni*
— Metatibial setae pale and inconspicuous 5

5. Large, greater than 2.6 mm long, epipleurae without darkened area on posterior portions of the tergites ..... *N. kirbyi*
— Medium size, less than 2.6 mm long, with light dusky marking on posterior portions of each epipleural tergite, giving the ventral margins of the abdomen a banded appearance (Fig. 8) ..... *N. undulata*

KEY TO THE WEST COAST FIFTH INSTAR *NOTONECTA* SPP.

1. Midventral carina of 4th abdominal segment largely bare, carinal hairs confined mostly to the sides of the carina (Fig. 9, 11) 2
— No bare area on carina; entire area covered with long or short hairs 5
2. Mesofemur with at least six long setae (those on the most proximal tubercle counted as one) ..... *N. kirbyi*
— Mesofemur with less than six setae 3
3. Mesofemur with only two setae, eyes prominent; dark conspicuous striping on meso- and metafemora and trochanters ..... *N. hoffmanni*
— Mesofemur with three large, and two small (fifth instar only) setae; striping restricted to the metafemora if present 4
4. Anterior aspect of vertex flattened ..... *N. indica*
— Anterior aspect of vertex rounded ..... *N. undulata*
5. Large, over 8 mm long, posterior angle of mesotrochanter rounded (Fig. 3) ..... *N. shooterii*
— Small, less than 8 mm long, mesotrochanter acutely rounded or toothed (Fig. 1, 2) 6
6. Posterior edge of mesotrochanter produced into tooth or stout tubercle (Fig. 2) ..... *N. spinosa*
— Mesotrochanter acutely rounded, but not toothed (Fig. 1) ..... *N. unifasciata*

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